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Mathematical paradoxes are largely connected with the squaring of the circle, the ratio π , the duplication of the cube, the trisection of the angle, and the number of the beast; astronomical paradoxes are quite as frequent, here, as the mathematical; religion, philosophy and medicine, too, enter in for a goodly share of attention. De Morgan had a very live interest in the history of science, and this interest finds frequent expression in the "Budget."

Not all the material, by any means, of these interesting volumes is concerned with paradoxes of the *nonsense* type. Le Verrier's planet Neptune is presented with certain original documents connected with the discovery; the names of Herschel, royal astronomer, and Brünnow, who was later director of the observatory at the University of Michigan, and Challis of the Cambridge Observatory are indications of a paradox, "something contrary to the current opinion" which was really revolutionary. Historical material appears with relative frequency, giving pleasant intervals of relief from regarding the errors of mankind.

Of particular interest are those notes which De Morgan inserts about men and affairs of his own time. The liberal footnotes added largely by Professor Smith, and occasionally by De Morgan's wife or from De Morgan's notes, contribute much to the modern reader's pleasure in perusing the volumes.

The "Budget," it need hardly be stated, was not intended to be read as a romance, although much of the material suggests that artistic rambling which is so delightfully characteristic of William De Morgan, the son of our mathematician Augustus De Morgan. Rather these are volumes to be read at odd moments, and always one will find profitable enjoyment. In spite of the interest and amusement with which we thumb the pages a feeling of sadness for the human frailty comes over the reader. De Morgan expresses this sentiment, too, in the brief but pointed comment on the work of an angle-trisector. After giving the title of the work De Morgan continues with a quotation of words from the author of the trisection, followed by five words of comment: "'The con-

sequence of years of intense thought': very likely, and very sad."

The physical make-up of this edition is up to the high standard which has been set by other publications of the Open Court Company. In every way the reader who takes these volumes in hand has pleasure in store; we commend the works to all who take a kindly interest not only in the greatness but equally in the frailty of their fellows.

LOUIS C. KARPINSKI

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Scottish National Antarctic Expedition. Report on the Scientific Results of the Voyage of the Scotia, during the Years 1902-4. Vol. IV., Zoology. Parts II.-XX., Vertebrates. Edinburgh, 1915. Pp. 505. 4to. 62 pl. 31 text-figures and 2 maps.

Before the voyage of the *Scotia* under the leadership of Dr. Wm. S. Bruce there had not been a deep-sea sounding taken south of S. Latitude 40° in the Atlantic Ocean. The uninviting lands of the South Orkneys, the South Shetlands and South Georgia, were rarely visited and relatively little known. As a direct result of the Swedish and Scottish expeditions in the Weddell Sea an extensive whale fishery has been developed having its headquarters at Leith. Now according to Dr. Bruce over a thousand people live in South Georgia, and during the summer months the South Orkneys and South Shetlands are a hive of industry, and altogether over five million dollars gross annual revenue is now taken in those regions previously regarded as worthless by business men.

Owing to the struggle in which the country is engaged, money for the publication of the scientific results could no longer be supplied by the treasury; and several of the reports were consequently issued in scientific periodicals, such as the *Ibis* and the *Proceedings of the Royal Physical Society*; but by the generosity of Sir Thomas Coats, the collaboration of the Scottish Oceanographical Society, the Carnegie Trust, the Royal Societies of Edinburgh and London and other friends and organizations, these and other papers are brought together in

this volume and illustrated in satisfactory form. Fifteen British naturalists have contributed papers, and the book is perhaps the most complete treatise on the Antarctic vertebrate fauna yet published.

The birds, seals, whales and fishes, are fully illustrated with excellent plates, and much space is given to anatomy, osteology and embryology; while the economic aspects of the fauna are not neglected. Papers on the tunicates and *Cephalodiscus* are included. A few forms obtained on the voyage but which are not strictly Antarctic are incidentally noticed. Altogether the members of the staff and the contributors to the explorations and publication of the results may justly congratulate themselves on the appearance of this handsome volume at a time when general attention is unfortunately diverted from matters of science and focused on the preservation of the empire.

WM. H. DALL

SPECIAL ARTICLES

THE CALCULATION OF TOTAL SALT CONTENT AND OF SPECIFIC GRAVITY IN MARINE WATERS¹

To the investigator engaged in biological studies on marine problems, it is often desirable to ascertain the concentration of sea-water in terms capable of correlation with life phenomena. Such concentration records usually take the form of density determinations made with some standard type of densimeter at the prevailing temperature. These density readings, while useful as physical records, are not directly adapted to physiological use. The quantity of salts present in sea-water is a term which can be so utilized and it becomes especially valuable in view of the fact that the proportion of constituents has been shown to vary but slightly, the concentration only being subject to considerable variation. By means of the *Challenger* proportions worked out by Dittmar² any total salt content can be resolved into its chief constituent parts. These proportions are as follows:

	Per Cent.
NaCl	77.758
MgCl ₂	10.878
MgSO ₄	4.737
CaSO ₄	3.600
K ₂ SO ₄	2.465
MgBr ₂	0.217
CaCO ₃	0.345

It has been shown that the total salt content is directly related to the specific gravity and that one may be calculated from the other. Specific gravity determinations are made with reference to different standard temperatures. Frequently density readings are made with the temperature indicated in Fahrenheit units. These are usually referred to 60° F. as a standard temperature, and the observed density is reduced to 60° F., sp. gr. 60° F./60° F. This is easily done by means of Libbey's tables.³ If the observed temperature is below 60° F. subtract the observed degrees of temperature from 60, multiply this difference by the correction found in the table opposite the observed temperature and *subtract* the product from the reading to be corrected. If the density is observed at a temperature above 60° F. ascertain as before the number of degrees of difference

Temp.	Correction for Reduction to 60° F.	Temp.	Correction for Reduction to 60° F.
I	II	I	II
50	-0.000108	70	+0.000145
51	-0.000110	71	+0.000146
52	-0.000112	72	+0.000147
53	-0.000113	73	+0.000148
54	-0.000115	74	+0.000149
55	-0.000118	75	+0.000151
56	-0.000120	76	+0.000152
57	-0.000120	77	+0.000154
58	-0.000120	78	+0.000156
59	-0.000120	79	+0.000157
60	+0.000125	80	+0.000158
61	+0.000130	81	+0.000159
62	+0.000135	82	+0.000160
63	+0.000137	83	+0.000162
64	+0.000137	84	+0.000163
65	+0.000138	85	+0.000164
66	+0.000140	86	+0.000166
67	+0.000141	87	+0.000167
68	+0.000142	88	+0.000168
69	+0.000143	89	+0.000170

¹ Published by permission of the Secretary of Agriculture.

² Dittmar, *Challenger Reports*, Physics and Chemistry, Vol. 1, Part 1, p. 138.

³ Libbey, William, "Physical Investigations off the New England Coast," Bull. U. S. Fish Commission, 9, pp. 397-398 (for 1889).